

The Impact of El Niño Southern Oscillation on Winter and Early Spring U.S. Tornado Outbreaks

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ABSTRACT

In recent years, the topic of seasonal predictability of tornado outbreaks has attracted the attention of researchers. Previous studies on this matter have focused mainly on the influence of global circulation patterns (e.g., El Niño Southern Oscillation (ENSO), North Atlantic Oscillation, Pacific Decadal Oscillation) on tornado outbreaks. However, these studies have yielded conflicting results of the roles of these climate drivers on tornado intensity and frequency. The present study seeks to establish linkages between ENSO and tornado outbreaks over the U.S. during winter and early spring. These linkages are established in two ways: 1) Statistically, by relating raw counts of tornadoes in outbreaks (defined as six or more tornadoes in a 24-hour period in the U.S. east of the Rocky Mountains), and their destructive potential, to sea surface temperature anomalies observed in the Niño 3.4 region; and 2) Qualitatively, by relating ENSO to shifts in synoptic-scale atmospheric phenomena that influence to tornado outbreaks. The latter approach is critical for interpreting the statistical relationships, thereby avoiding the deficiencies in previous studies that failed to provide physical explanations relating ENSO to shifts in tornado activity. The results suggest shifts in tornado occurrence are clearly related to ENSO. In particular, La Niña conditions consistently foster more frequent and intense tornado activity compared with El Niño, particularly at higher latitudes (Fig. 1). Tornado activity changes are tied not only to the location and intensity of the subtropical jet during individual outbreaks, but also to the positions of surface cyclones, low-level jet streams, and instability axes.

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References

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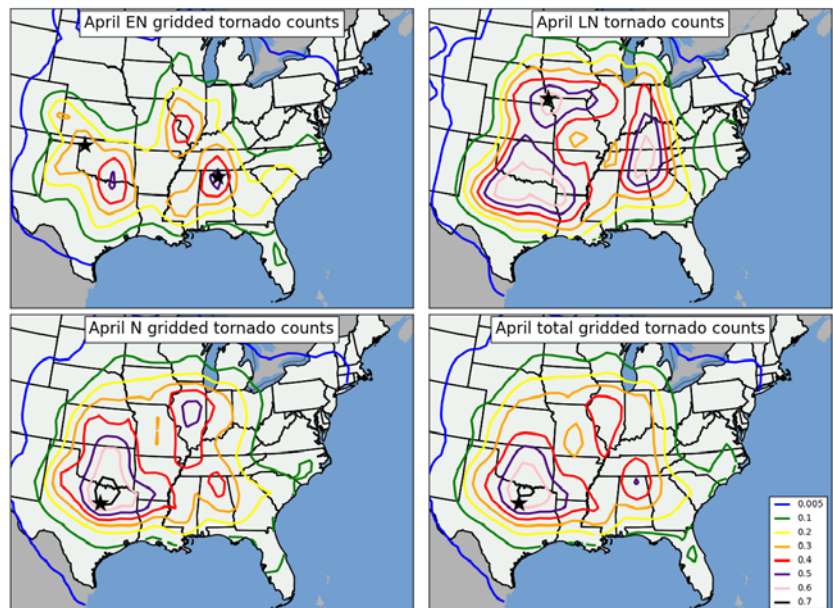


Fig. 1 Contour plots representing normalized gridded tornado counts during April in each ENSO phase. Tornado data was normalized against the number of April months classified as El Niño (EN), La Niña (LN), and Neutral (N). The black stars indicate locations of maximum normalized tornado occurrences.